SPECIFICATION

TITLE OF THE INVENTION

5   STORAGE CONTROLLING APPARATUS, STORAGE APPARATUS AND
RECONNECTION CONTROLLING METHOD IN THE STORAGE
APPARATUS

BACKGROUND OF THE INVENTION

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1) Field of the Invention

The present invention relates to a technique
applied   to   a   storage   controlling   apparatus
controlling an access from a host to a physical device,
15   and   a   storage   apparatus   including   the   storage
controlling   apparatus   and   the   physical   device.
Specifically,   the   present   invention   relates   to   a
technique   for   improving   a   reconnection   operation
between the host and the storage controlling apparatus
20   (storage apparatus).

2) Description of the Related Art

FIG. 6 is a block diagram showing a structure
of   a   known   storage   apparatus   (storage   controlling
apparatus).   A   storage   apparatus   1   shown   in   FIG.   6
25   writes data from a host 4, or reads out data requested
by the host 4 and transfers the data to the host 4 in
response   to   an   access   (an   input/output   request;

referred to as an I/O request, occasionally) from the host 4 such as a main frame or the like.

The storage apparatus 1 comprises a disk enclosure 2 having a plurality of disk units (disk apparatuses, physical devices) 2a, and a storage controlling apparatus 3 disposed between the disk units 2a and the host 4 to control an access from the host 4.

The storage controlling apparatus 3 comprises a disk interface module 10, a host interface module 20, a management module 30 and a PCI bridge module 40.

The disk interface module 10 controls an interface (data transfer) with each of the disk units 2a in the disk enclosure 2 through a disk interface bus 54.

The host interface module 20 controls an interface (data transfer) with the host 4 through a fiber channel interface bus 50.

The management module 30 generally manages the whole of the storage controlling apparatus 3. The management module 30 is equipped with a cache memory temporarily storing data to be written in one of the disk units 2a from the host 4 or data to be read out from one of the disk units 2a to the host 4, and manages the cache memory.

To the PCI bridge module 40, connected are

the disk interface module 10, the host interface module 20 and the management module 30 through PCI buses (interface buses) 51, 52 and 53. Thus, the PCI bridge module 40 connects the disk interface module

5 10, the host interface module 20 and the management module 30 to one another so that data can be transferred among them.

In the above structure, data writing from the host 4 into one of the disk units 2a and data

10 reading-out from one of the disk units 2a to the host 4 are carried out as follows.

When data is written from the host 4 into one of the disk units 2a in the disk enclosure 2, the data to be written is transferred from the host 4 to the

15 host interface module 20 through the fiber channel interface bus 50, and temporarily stored in the cache memory of the management module 30 from the host interface module 20 via the PCI bridge module 40 through the PCI buses 52 and 53, (refer to an arrow

20 A1 in FIG. 6). After that, the data to be written stored in the cache memory of the management module 30 is transferred to the disk interface module 10 via the PCI bridge module 40 through the PCI buses 53 and 51, and written in a predetermined disk unit 2a from

25 the disk interface module 10 through the disk interface bus 54 (refer to an arrow A2 in FIG. 6).

Conversely, when data is read out from one

of the disk units 2a in the disk enclosure 2 to the host 4, the data to be read out is transferred from a disk unit 2a retaining the data to the disk interface module 10 through the disk interface bus 54, and

5   temporarily stored from the disk interface module 10 in the cache memory of the management module 30 via the PCI bridge module 40 through the PCI buses 51 and 53 (refer to an arrow A3 in FIG. 6). After that, the data to be read out stored in the cache memory of the

10   management module 30 is transferred to the host interface module 20 via the PCI bridge module 40 through the PCI buses 53 and 52, and read out to the host 4 from the host interface module 20 through the fiber channel interface bus 50 (refer to an arrow A4

15   in FIG. 6).

When a data read-out request is notified as an I/O request from a channel (refer to a reference character 4a in FIG. 8) of the host 4 to the storage controlling apparatus 3, the management module 30 has

20   to perform a process (staging) of reading out data to be read out from the disk unit 2a into the cache memory if the data to be read out according to the data read-out request is not retained in the cache memory of the management module 30.

25   In such case, a communication connected state established between the host 4 and the host interface module 20 is once disconnected. When the data to be

read out is read out into the cache memory after that, a reconnection request is issued from the management module 30 to the host 4 through a path, through which the above request has been received, reconnection is

5 performed, then an I/O process corresponding to the above data read-out request is resumed. Such reconnection (re-coupling) is disclosed in patent documents 1 through 4 described hereinafter.

Now, description will be made of a known

10 reconnection operation with reference to a sequence diagram shown in FIG. 7. First, the I/O request (for example, a data read-out request) is notified from the channel (CH) 4a of the host 4 to the management module 30 via the host interface module 20 (refer to arrows

15 A11 and A12). When a waiting time occurs at the time of processing the I/O request (for example, in the case of staging as above), the communication connected state established between the channel 4a of the host 4 and the interface module 20 is once disconnected by

20 the storage controlling apparatus 3.

When the staging of the data to be read out is completed, the management module 30 issues a reconnection request (Req-in request) to the channel 4a of the host 4 through a path, through which the above

25 I/O request has been received (refer to arrows A13 and A14). When receiving the reconnection request, the channel 4a sends back a response to the host interface

module 20 (refer to an arrow A15). The host interface module 20 notifies the management module 30 of the received response (refer to an arrow A16).

When the response from the channel 4a is a notice that reconnection succeeds, the management module 30 resumes a process corresponding to the above I/O request with the channel 4a (refer to arrows A17 and A18). When the response from the channel 4a is a notice that the reconnection fails, the management module 30 again carries out (re-tries) the process at and after the arrow A13 shown in FIG. 7.

When data or signals are transferred between the host interface module 20 and the management module 30, the data or signals are transferred via the PCI bridge module 40, in general. In FIG. 7, illustration of the PCI bridge module 40 (namely, illustration of that the data or signals are transferred via the PCI bridge module 40) is omitted.

As the above reconnection, a function called DPR (Dynamic Path Reconnection) is used. The DPR function is a function of dynamically executing reconnection using any one of paths belonging to a path group formed between the host 4 and the storage controlling apparatus 3 (i.e., a path group to which a path, through which the I/O request has been received, belongs) irrespective of the path through which the I/O request has been received when reconnection is

carried out between the host 4 (channel 4a) and the storage controlling apparatus 3.

As such DPR function, there are two systems (a first system and a second system) as follows.

5   In the first system (one path mode), the reconnection request is issued to paths belonging to the same path group one by one through the host interface module 20, and the host interface module 20 is requested to perform the I/O process using a path which succeeds in the reconnection at the point of time that the reconnection succeeds. Namely, the reconnection request is issued to one path, and when the reconnection fails with the path, the reconnection request is issued to another path belonging to the same path group. This procedure is repeated until the reconnection succeeds.

In the second system (scattering mode), the reconnection request is issued to all paths belonging to the same path group through the host interface module 20 concurrently or almost concurrently, and the host interface module 20 is requested to perform the I/O process using a path which first succeeds in the reconnection. Namely, the reconnection request is scattered to all paths forming the same path group, and a path which first succeeds in reconnection is requested to resume the I/O process. Incidentally, other reconnection requests are assigned to the second

and later paths. When no request is present, cancel is notified to the paths (host interface module 20).

When a certain path is in the busy state because of another process or because a fault occurs in the path during disconnection, reconnection is possible with another path belonging to the same path group with the above DPR function. As shown in FIG. 8, for example, even when a certain path cannot be reconnected because the path is busy or in trouble (refer to an arrow A22) at the point of time that the disk interface module 10 completes staging of the I/O request (data read-out request) to be reconnected (refer to an arrow A21), another path belonging to the same group is assigned by the management module 30, and reconnection becomes possible with the path (refer to arrows A23 and A24).

[Patent Document 1] Japanese Patent Laid-Open Publication No. SHO 61-003261

[Patent Document 2] Japanese Patent Laid-Open Publication No. HEI 02-148158

[Patent Document 3] Japanese Patent Laid-Open Publication No. HEI 08-083234

[Patent Document 4] Japanese Patent Laid-Open Publication No. 2000-020445

In the above first system (one path mode), when the start (I/O request) of another I/O process and the reconnection request from the host 4 occur at

the same time, the reconnection request is withdrawn because the start of the I/O process has generally priority over the reconnection request. The reconnection request thus has to be reissued to 5 another path. In the first system in which the reconnection request is issued one by one, the I/O processing time is prolonged when a number of I/O requests waiting for reconnection are present in the storage controlling apparatus 3. When the start of 10 the I/O process and the reconnection request occur at the same time in such situation, the I/O processing time is largely prolonged (occurrence of subduction phenomenon).

When a number of I/O requests waiting for 15 reconnection are present in the storage controlling apparatus 3, the second system (scattering mode) is very effective because the reconnection request can be efficiently issued. However, when the number of I/O requests waiting for reconnection is small, the 20 busy rate of the paths (channels) is unnecessarily increased, which obstacles the start of a new I/O process.

SUMMARY OF THE INVENTION

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In the light of the above problems, an object of the present invention is to solve the wait state

when the number of input/output requests waiting for reconnection is large to prevent the I/O process from being prolonged (subduction), or to suppress an unnecessary increase in busy rate when the number of

5 I/O requests waiting for reconnection is small to prevent the start of a new I/O process from being obstructed, by dynamically switching between the two kinds of DPR system according to the conditions.

The present invention therefore provide a

10 storage controlling apparatus, disposed between a physical device and a host, for controlling an access from the host to the physical device, the storage controlling apparatus comprising one or more host interface modules, connected to a plurality of

15 channels of the host through a plurality of paths belonging to the same path group, for controlling an interface with the host, a management module for generally managing the whole of the apparatus, the management module comprising a reconnection queue for

20 enqueuing information on one or more input/output requests to be reconnected among input/output requests from the channels of the host as control blocks, and managing the enqueued control blocks, a monitoring means for monitoring the number of the

25 enqueued control blocks in the reconnection queue, a controlling means, when an I/O process corresponding to one of the one or more control blocks managed in

the reconnection queue is resumed, for controlling resumption of the I/O process in either a first system of issuing a reconnection request to each of the paths belonging to the same path group one by one through the host interface module and requesting the host interface module to perform the I/O process using a path first successful in reconnection at the point of time that the reconnection succeeds, or a second system of issuing concurrently or almost concurrently the reconnection request to the plural paths belonging to the same path group through the one or more host interface modules and requesting the host interface module to perform the I/O process using a path which first succeeds in the reconnection, and a switching means for dynamically switching the system to be executed by the controlling means to either the first system or the second system according to the number of the enqueued control blocks monitored by the monitoring means.

When the number of the enqueued control blocks monitored by the monitoring means is not larger than a predetermined number, the switching means switches the system to be executed by the controlling means to the first system. When the number of the enqueued control blocks monitored by the monitoring means exceeds the predetermined number, the switching means switches the system to be executed by the

controlling means to the second system.

The management module may further comprise a management table for managing a use status of each of the paths through the one or more host interface modules, and when the first system is executed, the controlling means may refer to the management table to issue the reconnection request to paths set free in the management table one by one through the host interface module. When said second system is executed, the controlling means may refer to the management table to issue the reconnection request concurrently or almost concurrently to two or more paths set free in the management table through the one or more host interface modules.

When the second system is executed, the controlling means may issue concurrently or almost concurrently the reconnection request to all paths belonging to the same path group through the one or more host interface modules. When the second system is executed, the controlling means successively requests the second and later paths which succeed in the reconnection to perform the I/O processes corresponding to one or more control blocks which can be reconnected among the control blocks managed in the reconnection queue.

The present invention futher provides a storage apparatus comprising a physical device and a

storage controlling apparatus disposed between the physical device and a host to control an access from the host to the physical device, the storage controlling apparatus comprising one or more host

5 interface modules, connected to a plurality of channels of the host through a plurality of paths belonging to the same path group, for controlling an interface with the host, a management module for generally managing the whole of the storage

10 controlling apparatus, the management module comprising a reconnection queue for enqueuing information on one or more input/output requests to be reconnected among input/output requests from the channels of the host as control blocks, and managing

15 the enqueued control blocks, a monitoring means for monitoring the number of the enqueued control blocks in the reconnection queue, a controlling means, when an I/O process corresponding to one of the one or more control blocks managed in the reconnection queue is

20 resumed, for controlling resumption of the I/O process in either a first system of issuing a reconnection request to each of the paths belonging to the same path group one by one through the host interface module and requesting the host interface module to perform the

25 I/O process using a path first successful in reconnection at the point of time that the reconnection succeeds, or a second system of issuing

concurrently or almost concurrently the reconnection request to the plural paths belonging to the same path group through the one or more host interface modules and requesting the host interface module to perform the I/O process using a path which first succeeds in the reconnection, and a switching means for dynamically switching the system to be executed by the controlling means to either the first system or the second system according to the number of the enqueued control blocks monitored by the monitoring means.

The present invention further provides a reconnection controlling method in a storage apparatus comprising a physical device and a storage controlling apparatus disposed between the physical device and a host to control an access from the host to the physical device, comprising the steps of enqueuing information on one or more input/output requests to be reconnected among input/output requests from a plurality of channels of the host as control blocks in a reconnection queue, and managing the enqueued control blocks,monitoring the number of said enqueued control blocks in the reconnection queue, and   resuming an I/O process corresponding to one of the one or more control blocks managed in the reconnection queue by dynamically switching, according to the number of the enqueued control blocks, to either a first system of issuing a reconnection

request to each of paths belonging to the same path group one by one and requesting to perform the I/O process using a path first successful in reconnection at the point of time that the reconnection succeeds,

5   or a second system of issuing the reconnection request concurrently or almost concurrently to said paths belonging to the same path group and requesting to perform the I/O process using a path which first succeeds in the reconnection.

10   In the storage controlling apparatus, the storage apparatus and the reconnection controlling method according to this invention, the monitoring means monitors the number of input/output requests waiting for reconnection as the number of control

15   blocks (information on input/output requests to be reconnected among input/output requests from channels of the host) in the reconnection queue, and the switching means switches the system of issuing the reconnection request by the controlling means to

20   either the fist system or the second system according to the number of the enqueued input/output requests. When the number of input/output requests waiting for reconnection is large, the wait state is quickly solved in the second system (scattering mode), thereby

25   to prevent prolongation of the I/O process (subduction). When the number of input/output request waiting for reconnection is small, an

unnecessary increase in busy rate of the path is suppressed by means of the first system (one path mode), thereby to certainly prevent the start of a new I/O process from being obstructed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a structure of a storage apparatus (a storage controlling apparatus) according to an embodiment of this invention;

FIG. 2 is a block diagram showing functional structures of essential parts of a management module shown in FIG. 1;

FIG. 3 is a diagram showing practical contents of a host interface module use status management table provided to the management module shown in FIG. 1;

FIG. 4 is a diagram for illustrating a practical operation of a reconnection queue according to the embodiment;

FIG. 5 is a sequence diagram for illustrating a reconnection operation (a reconnection controlling method in the storage apparatus) according to the embodiment;

FIG. 6 is a block diagram showing a structure of a known storage apparatus (a storage controlling

apparatus);

FIG. 7 is a sequence diagram for illustrating a known reconnection operation; and

FIG. 8 is a diagram for illustrating a known

5   DPR function.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, description will be made of an

10 embodiment of this invention with reference to the drawings.

[1] Description of an Embodiment of the Invention

FIG. 1 is a block diagram showing a structure of a storage apparatus (storage controlling

15 apparatus) according to an embodiment of this invention. As shown in FIG. 1, a storage apparatus 1A according to this embodiment is almost similar in structure to the known storage apparatus 1 shown in FIG. 6.

20 The storage apparatus 1A according to this embodiment writes data from a host 4, or reads out data requested by the host 4 and transfers the data to the host 4, in response to an access from the host 4. The storage apparatus 1A comprises a disk enclosure 2

25 having a plurality of disk units (magnetic disk units, physical devices) 2a, and a storage controlling apparatus 3A disposed between the disk units 2a and

the host 4 to control an access from the host 4 to each of the disk units 2a.

As shown in FIG. 1, the storage controlling apparatus 3A according to this embodiment, basically,
5   comprises a disk interface module 10, a host interface module 20, a management module 30A and a PCI bridge module 40 almost like the known storage controlling apparatus 3 shown in FIG. 6.

The disk interface module 10 controls an
10   interface (data transfer) with each of the disk units 2a in the disk enclosure 2 through a disk interface bus 54.

The host interface module 20 is connected to a plurality (four in this embodiment) of channels 4a
15   of the host 4 through a plurality (four in this embodiment) of paths 61 belonging to the same path group 60 (fiber channel interface bus 50) to control an interface (data transfer) with the host 4. Incidentally, it is possible to provide one host
20   interface module 20 to each of the paths 61, or to a plurality of paths 61.

The management module 30A generally manages the whole of the storage controlling apparatus 3A. The management module 30A is equipped with a cache
25   memory temporarily storing data to be written from the host 4 into one of the disk units 2a or data to be read out from one of the disk unit 2a to the host 4, and

manages the cache memory. Detailed structure of the management module 30A will be described later with reference to FIG. 2.

To the PCI bridge module, connected are the disk interface module 10, the host interface module 20 and the management module 30A through PCI buses 51, 52 and 53. Accordingly, the PCI bridge module connects the disk interface module 10, the host interface module 20 and the management module 30A to one another so that data can be transferred among them.

In the storage controlling apparatus 3A having the above structure according to this embodiment, data writing from the host 4 into a disk unit 2a and data reading-out from a disk unit 2a to the host 4 are carried out in manners similar to those carried out in the above storage controlling apparatus 3 (refer to the arrow A1 through A4 in FIG. 6).

Next, description will be made of functional structures (functional structures relating to a reconnection operation) of essential parts of the management module 30A according to this embodiment, with reference to a block diagram shown in FIG. 2.

As shown in FIG. 2, the management module 30A comprises a reconnection queue 31, a monitoring means 32, a controlling means 33, a switching means 34 and a host interface module use status management table 35.

The reconnection queue 31 enqueues control blocks [hereinafter referred to as ACBs (Action Control Blocks)] about all I/O requests to be reconnected due to staging process wait, for example,
5   among I/O requests (input/output requests) from the channel 4a of the host 4, and manages the enqueued control blocks. The reconnection queue 31 is provided to each of the management modules 30A. No limitation is specifically placed on the number of
10 enqueued control blocks in the reconnection queue 31.

The monitoring means 32 monitors the number of enqueued ACBs in the reconnection queue 31.

When resuming the I/O process corresponding to an ACB managed in the reconnection queue 31, the
15 controlling means 33 executes issuance of the reconnection request (Req-in request) in the first system (one path mode) or the second system (scattering mode), and controls resumption of the process (I/O process) corresponding to the I/O
20 request.

In the first system (one path mode), as described hereinbefore, the reconnection request is issued to the paths 61 belonging to the same path group 60 one by one through the host interface module 20,
25 and the host interface module 20 is requested to perform the I/O process using a path 61 successful in the reconnection at the point of time that the

reconnection succeeds. Namely, the reconnection request is issued to a certain path 61, and when the reconnection does not succeed with the path, the reconnection request is issued to another path 61 belonging to the same path group 60. This procedure is repeated until the reconnection succeeds.

In the second system (scattering mode), the reconnection request is issued concurrently or almost concurrently to each of all paths 61 belonging to the same path group 60 through the host interface module 20, and the host interface module 20 is requested to perform the I/O process using a path 61 which first succeeds in the reconnection, as described hereinbefore. Namely, the reconnection request is scattered to all the paths 61 forming the same path group 60, and a path which first succeeds in the reconnection is requested to resume the I/O process. With regard to the second and later paths 61 which succeed in the reconnection, the controlling means 33 scans the reconnection queue 31 to search for ACBs which can resume the I/O process, and assigns the reconnection requests relating to ACBs which can resume the I/O process to them. When no ACB which can resume the I/O process is present, the controlling means 33 notifies the paths 61 (host interface module 20) of cancellation.

The switching means 34 dynamically switches

the issuing system of the reconnection request to be
executed by the controlling means 33 to either the
first system or second system according to the number
of enqueued control blocks (the number of ACBs)
5   monitored by the monitoring means 32. Specifically,
the switching means 34 according to this embodiment
switches the reconnection request issuing system to
be executed by the controlling means 33 to the first
system (one path mode) when the number of enqueued
10   control blocks monitored by the monitoring means 32
is not larger than a predetermined number (a threshold
value; for example, four). When the number of
enqueued control blocks monitored by the monitoring
means 32 exceeds the predetermined number, the
15   switching means 34 switches the reconnection request
issuing system to be executed by the controlling means
33 to the second system (scattering mode). Even when
the number of ACBs in the reconnection queue 31 drops
to the threshold value or below immediately after the
20   switching means 34 switches the reconnection request
issuing system to the second system, the switching
means 34 does not immediately switch the reconnection
request issuing system, but maintains the scattering
mode of the second system for at least five seconds,
25   for example.

The host interface module use status
management table (management table) 35 manages the

used/unused state of each of the paths 61 through each of the host interface modules 20. The host interface module use status management table 35 is provided to each of the management modules 30A. In the host

5   interface module use status management table 35, an ID (identification information) of each of the host interface modules 20 is related to used/unused state information on the host interface module 20 (i.e., used/unused state information on a path 61 connected

10   to the host interface module 20), and "1" or "0" is set and retained, as shown in FIG. 3, for example. For instance, when the host interface module 20 is in the free state (unused state), "0" is retained. When the host interface module 20 is in the used state, "1" is

15   retained.

Timings to update the host interface module use status management table 35 are at the points of time that the I/O request is received ("0" → "1"), that the channel 4a and the host interface module 20

20   are disconnected ("1" → "0"), that the I/O process is completed ("1" → "0"), and that the reconnection request is issued ("0" → "1"). The term "free state" used here represents only a state in which "own management module 30A does not use the host interface

25   module 20," not assuring that "another management module 30A does not use it as well."

When one host interface module 20 is provided

to one path 61, identification information that can specify a physical host interface module 20 is used as an ID of the host interface module 20. When a plurality of paths 61 are connected to one host

5 interface module 20, identification information that can specify one logical host interface module that can be assumed for each path 61 (logical interface module) is used as an ID of the host interface module 20.

The controlling means 33 refers to the host

10 interface module use status management table 35 described above to issue the reconnection request to a host interface module 20 not used by at least its own management module 30A. For example, when executing the first system (one path mode), the

15 controlling means 33 issues the reconnection request to host interface modules 20 to which the free state "0" is set in the host interface module use status management table 35 one by one. When executing the second system (scattering mode), the controlling

20 means 33 issues the reconnection request concurrently or almost concurrently to two ore more host interface modules 20 to which the free state "0" is set in the host interface module use status management table 35.

Therefore, the management module 30A

25 according to this embodiment does not issue the reconnection request to host interface modules 20 (logical host interface modules) in the used state,

but issues the reconnection request to only host interface modules 20 in the free state. When all the host interface modules 20 are in the used state, the management module 30A waits to issue the reconnection

5   request until at least one host interface module 20 is brought to the free state. Namely, each of the management modules 30A does not issue the reconnection request plural times to one host interface modules 20.

Timing to issue the reconnection request from

10   the controlling means 33 to the host interface module 20 is at the point of time that an ACB is enqueued in the queue or that the host interface module 20 is brought to the free state (the unused state). At either point of time, the controlling means 33 scans

15   the reconnection queue 31 from the leading ACB, and checks whether or not any ACB which can be reconnected (can resume the I/O process) is present.

Next, description will be made of the reconnection operation (reconnection controlling

20   method) by the storage apparatus 1A (storage controlling apparatus 3A, management module 30A) structured as above according to this embodiment, with reference to FIGS. 4 and 5. FIG. 4 is a diagram for illustrating a practical operation of the

25   reconnection queue according to this embodiment. FIG. 5 is a sequence diagram for illustrating the reconnection operation (reconnection controlling

method in the storage apparatus 1A) according to this embodiment.

A reconnection request (Req-in request) of an ACB retained in the reconnection queue 31 is
5 executed with action input/output blocks (hereinafter referred to as AIOs) prepared by extracting and copying information necessary for the reconnection request from control information in the ACB, as shown in FIG. 4. Namely, the controlling
10 means 33 of the management module 30A acquires AIOs in number equal to the number of host interface modules 20, to which the reconnection request is to be issued, from ACBs to be reconnected in the reconnection queue 31, and issues the reconnection request to each of the
15 host interface modules 20 (each of paths 61) on the basis of each of the AIOs.

According to this embodiment, when the management module 30A is in the high loaded state (for example, the number of ACBs in the reconnection queue
20 31 monitored by the monitoring means 32 is not less than five), the switching means 34 switches the mode to the second system (scattering mode), and the controlling means 33 acquires as many AIOs as possible in order to issue the reconnection request to as many
25 host interface modules in the free state as possible. When the management module 30A is in the low loaded state (for example, the number of ACBs in the

reconnection queue obtained by the monitoring means

32 is not larger than four), the switching means 34

switches the mode to the first system (one path mode),

and the controlling means 33 acquires only one AIO in

5   order to issue the reconnection request to one host

interface module 20 in the free state, thereby to

decrease the busy rate of the channels 4a (paths 61).

When six ACBs, ACB0, ACB2, ACB5, ACB7, ACB1

and ACB8, are managed as ACBs in the reconnection queue

10   31 as shown in FIG. 4, for example, assuming here that

the I/O process relating to ACB 7 is brought to the

resumable state, and two host interface modules 20

(their IDs are assumed to be 0 and 1) are in the free

state at that point of time (information on this free

15   state being obtained from the host interface module

use status management table 35 as described above).

In the above situation, the controlling means

33 acquires two AIOs, AIO-0 and AIO-1, assigned to the

two host interface modules 20 (host interface module

20   "0" and host interface module "1") with respect to ACB

7, as shown in FIG. 4, and issues the reconnection

request (Req-in request) to the two host interface

modules 20 (host interface module "0" and host

interface module "1") from the management modules 30A

25   on the basis of AIO-0 and AIO-1 (refer to an arrow A31

in FIG. 5).

After that, the reconnection first succeeds

with a path 61 between the host interface module "0" and the channel 4a of the host 4, and success of the reconnection is notified from the host interface module "0" to the management module 30A (refer to an arrow A32 in FIG. 5). In response to this, the management module 30A requests the host interface module "0" to resume the I/O process corresponding to ACB 7 (refer to an arrow A33 in FIG. 5).

Following that, the reconnection succeeds with a path 61 between the host interface module "1" and the channel 4a of the host 4, and success of the reconnection is notified from the host interface module "1" to the management module 30A (refer to an arrow A34 in FIG. 5). In response to this, the management module 30A (controlling means 33) scans the reconnection queue 31 to search for another ACB that can resume the I/O process and has the same requester as the I/O request corresponding to ACB 7 (refer to step S10 in FIG. 5). Assuming here that ACB 8 meets this condition, the controlling means 33 requests the host interface module "1" to resume the I/O process corresponding to ACB 8 (refer to an arrow A35 in FIG. 5). When no ACB meeting the above condition is present in the connection queue 31, the controlling means 33 notifies the host interface module "1" of cancellation of the reconnection.

When only one host interface module 20 in the

free state is present or when the mode is switched to the first system (one path mode) by the switching means 34, only one AIO is acquired, and the reconnection request is issued to one host interface module 20 in

5 the free state.

When data or signals are transferred between the host interface module 20 and the management module 30A, the data or signals are normally transferred via the PCI bridge module 40. In FIGS. 5 through 8,

10 illustration of the PCI bridge module 40 is omitted (namely, illustration of that the data or signals are transferred via the PCI bridge module 40 is omitted).

According to this embodiment, in the storage controlling apparatus 3A (in the reconnection

15 controlling method in the storage apparatus 1A), the monitoring means 32 monitors the number of I/O requests waiting for reconnection as the number of ACBs in the reconnection queue 31, and the switching means 34 dynamically switches the method of issuing

20 the reconnection request by the controlling means 33 to the first system (one path mode) or the second mode (scattering mode) according to the number of ACBs.

When the number of I/O requests waiting for reconnection is large (at the time of large load; when

25 the number of ACBs exceeds the threshold value), the reconnection request is issued to a plurality of host interface modules 20 (paths 61) in the free state

concurrently or almost concurrently in the second system (scattering mode), so that the waiting state is promptly solved and prolongation (subduction) of the I/O process time is prevented.

5   When the number of the I/O requests waiting for reconnection is small (at the time of small load; when the number of ACBs is equal to or below the threshold value), the reconnection request is issued to only one host interface module 20 (path 61) even

10 when a plurality of host interface modules in the free state are present, so that unnecessary increase in busy rate of the paths 61 is suppressed and obstruction to the start of a new I/O process is certainly prevented.

15 [2] Others

        Note that the present invention is not limited to the above embodiment, but may be modified in various ways without departing from the scope of the invention.

20   For example, the threshold value which is a reference for switching between the first system and the second system is "four" in the above embodiment, but this invention is not limited to this.

        The interface between the host 4 and the

25 storage controlling apparatus 3A is a fiber channel interface in the above embodiment, but this invention is not limited to this.

Functions of the monitoring means 32, the controlling means 33 and the switching means 34 in the above embodiment are realized by running a predetermined program by a CPU (Central Processing

5   Unit; not shown) of the management module 30A. This program is provided in a form in which the program is recorded on a computer readable record medium such as flexible disk, CD-ROM, CD-R, CD-RW, DVD or the like, for example. Accordingly, the functions according to

10   this invention (storage controlling apparatus 3A, management module 30A) are accomplished by only changing the software without specifically adding to and/or changing the known hardware. The functions of the reconnection queue 31 and the host interface

15   module use status management table 35 are accomplished by using an area of a memory (not shown) originally provided to the management module 30A.